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## THE GENUS *KRADIBIA* SAUNDERS AND AN ADDITION TO *CERATOSOLEN* MAYR (HYMENOPTERA CHALCIDOIDEA, AGAONIDAE)

by

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With 60 text-figures

### ABSTRACT

Revision of *Kradibia* Saunders, with descriptions of new species *hilli* (type ♀, Uganda, host *Ficus urceolaris* auctt. = *F. stortophylla* Warb.) and *setigera* (type ♀, Borneo, host *F. leptogramma* Corner), and redescrptions of *K. brownii* Ashmead (Philippines, host *F. ulmifolia* Lam.) and *K. cowani* Saunders (Madagascar, host *F. ? soroceoides* Baker; Réunion, host *F. morifolia* Lam.). One species of *Ceratosolen* from a *Sycidium*-fig is described, viz., *C. internatus* (type ♀, Java, host *Ficus asperiuscula* K. & B.).

The fig wasp genus *Kradibia* was described in 1883 by Saunders, for the new species *K. cowani* from Madagascar. A few years later, Mayr (1885: 152) noted that he could not distinguish generically between *Kradibia* and *Blastophaga* Gravenhorst, 1829. The fact that Mayr repeated this remark with the description of *B. quadrupes* from *Ficus diversifolia* Bl. (*deltoidea* Jack), indicates his sense of some relationship between *K. cowani* and the pollinators of *Sycidium*-figs. One of these was later described as *Liporrhopalum* Waterston, 1920; in 1969, Hill revised and redefined this genus. Little later again (Wiebes, 1969), I widened the generic definition, adding *Blastophaga gestroi* Grandi, 1916, known from Ceylon and India (Grandi, 1928a: 79), but then also recorded from Africa, and I suggested that *Kradibia* as well as *Kradibiella* Girault, 1915, might be older available names. Grandi (1916a: 123-124) also mentioned *K. cowani* in one breath with *B. gestroi* and some other species, but he did not want to distinguish them as a separate taxon. In 1904, Ashmead had recognized another species, later found to be connected with *Sycidium*-figs, which he described as *Kradibia brownii*.

It fits in the genus as understood here, and the species is redescribed below.

The collection on which the present report is based contains *Kradibia cowani* from Madagascar, expertly collected by L. & R. Blommers (then at ORSTOM, Madagascar), next to several other samples identical or allied to it, collected by E. J. H. Corner (Cambridge, England, who also identified the Indo-Malayan species of *Ficus*), J. Decelle (Musée Royal de l'Afrique centrale, Tervuren, Belgium), J. Etienne (IRAT - Réunion), D. S. Hill (then at Makerere University, Kampala, Uganda), A. Hladik (Laboratoire d'Ecologie, Brunoy, France), J. Kielland (collection made in Tanganyika, bought by the Leiden Museum), G. Michaloud (Laboratoire de Primatologie et d'Ecologie équatoriale, Makokou, Gabon), L. E. Newton (University of Science and Technology, Kumasi, Ghana), J. van der Vecht (collection made in Java), A. Watsham (Salisbury, Rhodesia), and by myself on a trip to the Philippines or taken from dried figs in the herbaria of Utrecht (C. C. Berg) and Wageningen (H. C. D. de Wit and G. Aweke). A few old samples, collected by F. X. Williams in the Philippines, were sent on loan from the collection of the Hawaiian Sugar Planters' Association (now in the Bernice P. Bishop Museum), Honolulu (HSPA). Some original slides of *K. cowani* could be studied thanks to the cooperation of J. S. Noyes and J. Quinlan of the British Museum (Natural History), London (BM). I am thankful to all colleagues mentioned for their kind help. The material is being preserved in the Rijksmuseum van Natuurlijke Historie, Leiden (RMNH).

### **Kradibia** Saunders

*Kradibia* Saunders, 1883, Trans. ent. Soc. Lond.: 20-25 (*Kradibia cowani* n.gen. n.sp., descr. ♀ ♂, Madagascar, Forest of Tianarantsoa, 4 mi from Antananarivo, leg. W. Deans Cowan, ex *Ficus* sp.); Mayr, 1885, Verh. zool.-bot. Ges. Wien, (B) 35: 152, 184 (syn. of *Blastophaga* Gravenhorst); Grandi, 1928c, Boll. Lab. Ent. Bologna, 1: 211, 213 (do., as in all subsequent editions of the catalogue up to 1963, Ibid., 26: 319, 321); Hill, 1967, Figs of Hong Kong: 91 (do.); Wiebes, 1969, Ann. Mus. Roy. Afr. centr. (in 8), 175: 460 (possibly good genus).

1) According to Grandi (1928b: 69-70; 1931: 8), the plant from which the wasps were collected is *W. G*(reenwood). 244, which Corner identified with *Ficus scabra*. I expect the wasps to be distinct from *K. brownii*, but I did not yet study Grandi's sample nor any other sample from this species of fig.

2) Corner (in litt.) confirmed the classification of these species of *Ficus* with series *Scabrae*.

3) The record of *K. brownii* (Grandi, 1927: 326) from *F. heterophylla* was made from the Philippines, where this fig species does not occur. According to Corner, all Philippine specimens identified with *F. heterophylla* actually belong to *F. ulmifolia*.

4) From here, I follow DeWolf (1964), although I changed the sequence of the series.

5) For a list of the series and species, see Hill (1969: 34-35).

TABLE I  
Figs of section *Sycidium*, and their pollinating wasps

<i>Ficus</i> L., section <i>Sycidium</i> Miq.	Agaonidae, Blastophaginae
SUBSECTION <i>Sycidium</i>	
	genus <i>Ceratosolen</i> Mayr (p.p.)
series <i>Prostratae</i> Corner	
<i>F. semicordata</i> B.Ham. ex J.E.Sm.	<i>C. gravelyi</i> Grandi
<i>Pungentes</i> Corner	
<i>F. pungens</i> Reinw. ex Bl.	<i>C. nanus</i> Wiebes
<i>F. minahassae</i> (Teyssm. ex Vr.) Miq.	<i>C. pygmaeus</i> Grandi
	<i>Blastophaga</i> Gravenhorst
<i>Phaeopilosae</i> Corner	
<i>F. conocephalifolia</i> Ridley	<i>B. jacobsi</i> Wiebes
<i>Copiosae</i> Corner	
<i>F. montana</i> Burm.f.	<i>B. tentacularis</i> Grandi
	<i>Kradibia</i> Saunders
<i>Scabrae</i> Miq.	
<i>F. ulmifolia</i> Lam.	<i>K. brownii</i> Ashmead
<i>F. ampelas</i> Burm.f.	<i>K. sumatrana</i> (Grandi)
<i>F. fraseri</i> Miq.	<i>K. ghigii</i> (Grandi)
<i>F. coronata</i> Spin.	<i>Kradibiella</i> sp., Wakefield 1960
<i>F. scabra</i> Forst.f.	<i>K. brownii</i> sensu Grandi 1928b <sup>1)</sup>
<i>F. soroceoides</i> Baker (Madagascar) <sup>2)</sup>	<i>K. cowani</i> Saunders
<i>F. morifolia</i> Lam. (Réunion) <sup>2)</sup>	<i>K. cowani</i> Saunders
SUBSECTION <i>Varinga</i> (Miq.) Corner	
<i>Heterophylleae</i> Corner	
<i>F. heterophylla</i> Linn.f.	<i>K. brownii</i> sensu Grandi 1927 <sup>3)</sup>
<i>F. capreaefolia</i> Del. <sup>4)</sup>	<i>K. ? gestroi</i> (Grandi)
<i>Exasperatae</i> Corner	
<i>F. exasperata</i> Vahl (India, Ceylon)	<i>K. g. gestroi</i> (Grandi)
<i>F. exasperata</i> Vahl (Africa)	<i>K. g. afrum</i> (Wiebes)
<i>Cyrtophylleae</i> Corner	
<i>F. asperifolia</i> Miq. in Hooker	<i>K. g. afrum</i> (Wiebes)
<i>F. stortophylla</i> Warb.	<i>K. hilli</i> Wiebes
<i>F. asperiuscula</i> Kunth. et Bouch.	<i>Ceratosolen internatus</i> Wiebes
<i>F. leptogramma</i> Corner	<i>K. setigera</i> Wiebes
SUBSECTION <i>Palaeomorphe</i> (King) Corner	<i>Liporrhopalum</i> Waterston <sup>5)</sup>

Diagnosis and host relations. — The delimitation of *Kradibia*, especially against *Liporrhopalum*, is not at all clear; *Liporrhopalum*, in its turn, seems ill defined against a portion of *Ceratosolen*. These groups are listed in table 1, with their host relations and the classification of *Ficus*, section *Sycidium*. General reference is here made to Corner (1965) for *Ficus*, Hill (1969) for *Liporrhopalum*, and Wiebes (1963) for *Ceratosolen*.

*Liporrhopalum*, as understood now (i.e., without *Blastophaga gestroi* and the other species mentioned by Wiebes, 1969: 460), is characteristic for figs from subsection *Palaeomorphe* of section *Sycidium*. Hill divided the genus in a number of species-groups, which generally appeared to correspond with the series recognized in *Ficus*, viz., *Pallidae* with species of the *L. gibbosae*-group, *Subulatae* with the *L. subulatae*-group, and *Cuspidatae* and *Fibrosifoliae* with the *L. midotis*-group, and *L. uniglandulosae*.

The group of *Ceratosolen* concerned is that of *C. pygmaeus*. Next to the species mentioned in the table, it contains *C. constrictus* and *hewitti* from *Ficus fistulosa* (section and subsection *Sycocarpus*), and *C. marshalli* from *F. pritchardii* (subsection *Papuasyce*, see Corner, 1970: 401).

Two species listed in the table cannot be classified with any of the genera mentioned, viz., *Blastophaga jacobsi* and *tentacularis*. The species were described in *Blastophaga* where, although now apparently displaced, they have to stay until a better location can be found.

The following characters of *Kradibia* may be compared with those of *Liporrhopalum*; some notes on the other groups are added.

Female. — Antennal segments with linear sensilla only, as in *Ceratosolen*; in *Liporrhopalum* there are two basic types, viz., long and flexible sensilla, and sensilla linearia;

wing venation distinct, as in *Ceratosolen*; distinct, faint or obsolete in *Liporrhopalum*;

as in all groups mentioned here, the females have rather large mesosternal pollen pockets, as figured for *Kradibia hilli* (fig. 34), and shallow coxal corbiculae, as figured for *K. brownii* (fig. 4) and *K. hilli* (figs. 35, 36);

fore tibia with four to six dorso-apical teeth; two to four in *Ceratosolen* (group of *C. pygmaeus* only!); two or three in *Liporrhopalum*.

Male. — Clypeus absent, scrobes covered; in *Liporrhopalum* the clypeus is present or absent (and then the scrobes are covered); in *Ceratosolen* the clypeus is always present (it seems to be the end of a transformation series from most *Kradibia*, over *K. ghigii* and some *Liporrhopalum*, e.g. *L. dubium* etc., to *Ceratosolen*);

fore tibia with a dorso-apical comb of at least seven, but in most species eight teeth; three or four teeth in *Liporrhopalum*, as also in most species of *Ceratosolen*;

fore tarsi bimerous in all groups mentioned, the trimerous *Kradibia hilli* excepted;

mid leg reduced to palp-like vestiges in most species of *Kradibia*, more complete in *K. gestroi* and *hilli*, and in the species of *Liporrhopalum* and *Ceratosolen*;

hind tarsi five-segmented, *Kradibia sumatrana* excepted (four-segmented); heteromerous in most species of *Liporrhopalum* and *Ceratosolen*.

As may be seen from the table, there is a general correspondence between the series of *Ficus* and the groups of the Agaonidae. One apparent deflection occurs in the *Cyrtophylleae*, where in the pollinator of *Ficus asperiuscula* a combination of characters is found, similar to that in species of *Ceratosolen* Mayr: if only for heuristic reasons, I describe the species in this genus (p. 180).

On the level of the subsections, the fit is less satisfactory, especially in and between *Sycidium* and *Varinga*. I shall have to return to this subject later, as I possess many more samples of about a dozen species of fig from subsection *Sycidium*. Most of them were collected on a trip to the Philippines, and they will be described in another context.

On the level of the specific relations, attention is drawn to the instance of *Kradibia gestroi*, being recorded from three species of fig, from three different series of *Varinga*: see the discussion on p. 177 of the present paper.

#### KEY TO THE SPECIES

1. Females (that of *Kradibia ghigii* is not known) . . . . . 2
- Males (that of *Kradibia setigera* is not known) . . . . . 7
2. Compound eye large,  $2\frac{1}{2}$  times as long as the cheek (fig. 49), epistomal margin straight; mandibular appendage with up to eight ventral lamellae (fig. 45); the head, body, and legs with long setae (Borneo, *F. leptogramma*) . . . . . *setigera*
- Compound eye smaller, at the most two times as long as the cheek or slightly longer (figs. 13, 25, 41), epistomal margin more distinctly lobed; mandibular appendage with less than eight ventral lamellae (figs. 14, 24, 37); the setae not particularly long . . . . . 3
3. Antennal segments, from the sixth onwards, three times as long as wide, with three rows of long sensilla (fig. 42); maxilla with a short bacilliform process (Uganda, Tanzania, *F. stortophylla*) . . . . . *hilli*
- Antennal segments shorter, at the most two times as long as wide . . . . . 4
4. Antennal segments widening apicad, rather long (fig. 23); maxilla with a long bacilliform process (fig. 24) (Madagascar and Réunion, *F. soroceoides* and *morifolia*) . . . . . *cowani*

- Antennal segments not particularly long, nor widening apicad; maxilla without a bacilliform process . . . . . 5
- 5. Antennal segments, from the fifth onwards, with a large number of small sensilla (fig. 10); compound eye rather small, distinctly less than two times as long as the cheek (fig. 13) (Philippines, *F. ulmifolia*) . *brownii*
- Antennal segments with one or two rows of long sensilla; compound eye twice as long as the cheek . . . . . 6
- 6. Antennal segments, from the sixth onwards, with one row of long sensilla, reaching beyond the apical rim of the segment; tenth segment divided, so as to suggest an eleven-segmented condition; mandibular appendage with five ventral lamellae; apical comb of the fore tibia with four teeth (Sumatra, Java, *F. ampelas*) . . . . . *sumatrana*
- Antennal segments with two rows of shorter sensilla, except for the African specimens in which there may be some with one irregular row; tenth segment not divided; mandibular appendage with four ventral lamellae; apical comb of the fore tibia with five teeth (India, Ceylon, Africa, *F. exasperata*) . . . . . *gestroi*
- 7. Mid leg slender, but rather complete i.e., up to and including distinguishable tarsal segments . . . . . 8
- Mid leg much reduced, consisting of one or two small palp-like vestiges on the mesosternum (figs. 8, 18) . . . . . 9
- 8. Antennal anellus very short; pronotum longer than wide (ca. 7 : 6); fore tarsus two-segmented (♀, couplet 6) . . . . . *gestroi*
- Antennal anellus longer (fig. 30); the pronotum not quite as long as wide (ca. 6 : 7) (fig. 29); fore tarsus three-segmented (♀, couplet 3) . . *hilli*
- 9. Hind tarsus with about six ventral teeth, and also with a number of dorsal teeth (figs. 2, 7, 17) . . . . . 10
- Hind tarsus with three or four ventral teeth, and one dorsal . . . . 11
- 10. Eyes small, one-seventh of the length of the head (fig. 1); metanotal plates fused in the middle (♀, couplet 5) . . . . . *brownii*
- Eyes larger, one-fifth of the length of the head (fig. 15); metanotal plates separate (♀, couplet 4) . . . . . *cowani*
- 11. Hind tarsus four-segmented; metanotal plates fused in the middle (♀, couplet 6) . . . . . *sumatrana*
- Hind tarsus five-segmented; metanotal plates separate (Australia, *F. fraseri*) . . . . . *ghigii*

#### **Kradibia brownii** Ashmead (figs. 1-14)

*Kradibia brownii* Ashmead, 1904, Ent. News, Philad., 15: 342 (descr. ♀, Philippines, Manila, leg. R. Brown); Grandi, 1927, Philipp. J. Sci., 33: 326 (Philippines, leg. C. F. Baker); Wiebes, 1963, Tijdschr. Ent., 106: 96 (disc. of host records).

Material. — Series ♀ ♂, Philippines, Luzon, Laguna, Los Banos (Coll. Agric. campus), leg. F. X. Williams, 24 & 27.i.1922, ex *Ficus ulmifolia* Lam.; HSPA, duplicates in RMNH 3244.

Series ♀ ♂, Philippines, Luzon, Camarines Sur, Higarón near Naga, leg. J. T. Wiebes, 2.i.1965, ex *Ficus ulmifolia* Lam. (J. V. Pancho no. 4237, det. E. J. H. Corner); RMNH 1485, ♀ and ♂ slide-mounted.

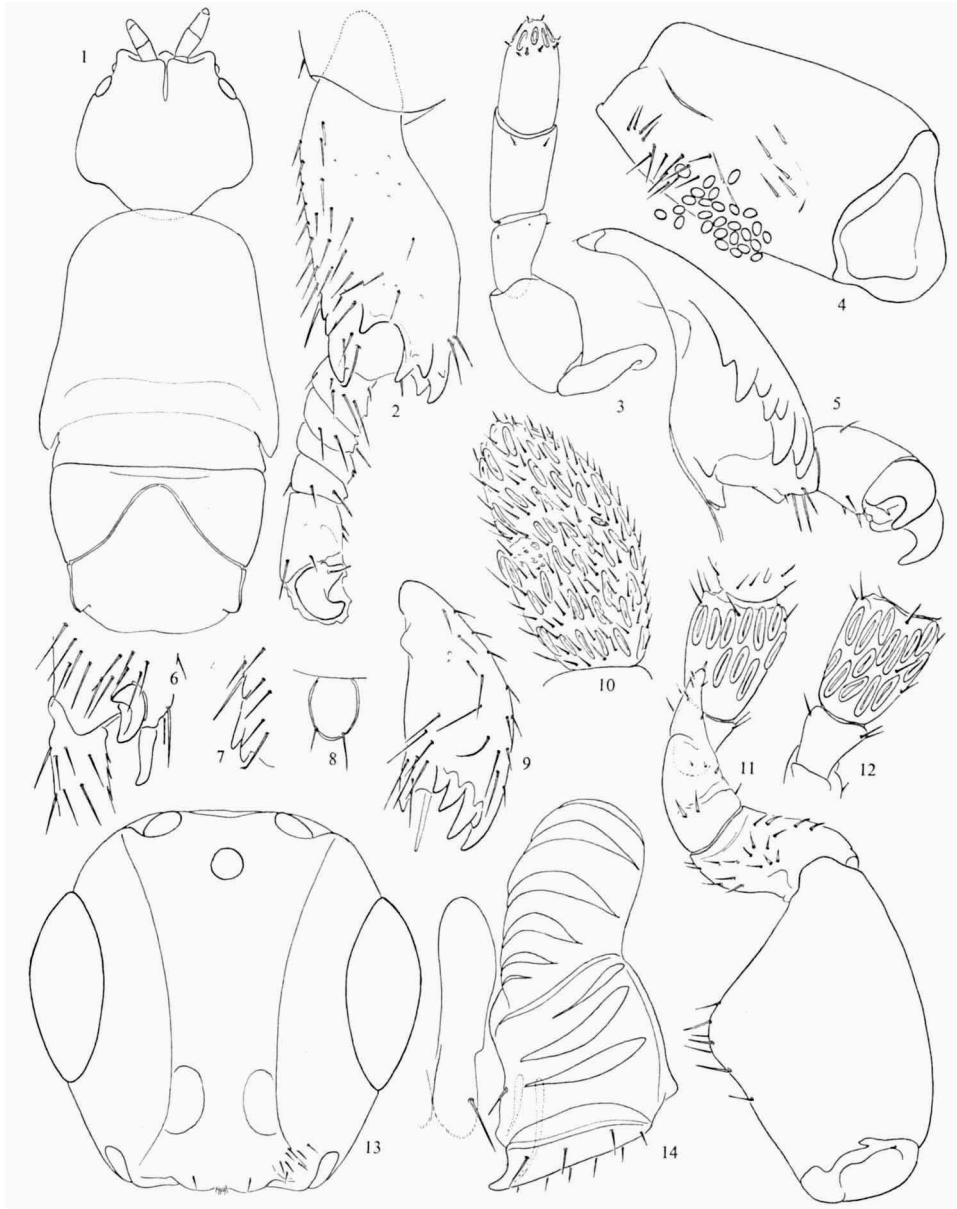
Description. — Female. Head (fig. 13) as long as wide across the compound eyes; the longitudinal diameter of the eye half as long as the head, and about  $1\frac{1}{2}$  times as long as the cheek (15 : 9). Three ocelli. Epistomal margin only faintly lobed; a patch of rather long setae occurs laterally, as indicated in the right corner of the figure. Antenna (figs. 10-12) ten-segmented; the segments are not particularly long, except for the sixth, which is up to two times as long as the others, and the tenth; the fifth bears a large number (ca. 25) of oblong sensilla, but almost no setae; the sixth to tenth bear many smaller sensilla and many setae, as indicated for the tenth (fig. 10); all segments from the fourth onwards are widening apicad. Mandible (fig. 14) bidentate, with two glands; four ventral lamellae, the appendage with six. Labium and maxillae (fig. 14) with one subapical seta on the maxillae; no bacilliform process.

Thorax. Fore wing (2 : 1), 1.6 mm long; the submarginal, marginal, stigmal, and postmarginal veins approximately in ratio 11 : 4 : 3 : 5, the membrane with dense microtrichia; the hind wing (4 : 1) 1.0 mm long. Fore leg: the coxa with a heavy patch of spine-like setae (sometimes with many pollen-grains in between, fig. 4); the tibia with the dorsal comb consisting of five teeth (fig. 9), a ventral tooth and a spur; the tarsal segments approximately in ratio 10 : 4 : 3 : 4 : 8. Mid leg: tarsal ratio 10 : 6 : 6 : 5 : 7. Hind leg (fig. 6): the coxa with only a few (i.e., three) small axial spines (as against six in *K. cowani*, and up to twelve in *K. gestroi* and *hilli*); the axial teeth of the tibia simple, the antiaxial almost bicuspidate; the tarsal segments approximately in ratio 11 : 4 : 4 : 3 : 5, with a plantar fringe.

Gaster: the hypopygium with a comparatively long spine, although not as long as in *K. hilli*; the spiracular peritremata of the eighth urotergite very small, and the pygostyle as will be described for *K. hilli* (see figs. 38, 39).

Length (head, thorax and gaster; fully stretched) 1.7 mm; the ovipositor 0.4 mm long i.e., about two-thirds of the gaster. Colour brown, the legs and antennae lighter.

Male. — Head (fig. 1) as long as wide, with many short spines much as in *K. gestroi* (Grandi, 1916b, fig. iii, 1), which it also otherwise resembles. Compound eyes small, the longitudinal diameter one-seventh of the length of the head. Antenna (fig. 3) consisting of five segments: the scape longer



Figs. 1-14. *Kradibia brownii* Ashmead, male (1-3, 5, 7-8) and female (4, 6, 9-14). 1, male head and thorax (setae omitted); 2, male hind tibia and tarsus, anti-axial aspect; 3, male antenna, dorsal aspect; 4, female fore coxa, axial aspect; 5, male fore tibia (setae omitted) and tarsus, anti-axial aspect; 6, apex of female hind tibia, anti-axial aspect; 7, ventral angle of male hind tibia (cf. fig. 2); 8, vestigial male mid leg; 9, female fore tibia, anti-axial aspect; 10-11, parts of female antenna in anti-axial aspect: 10, ultimate segment, 11, scape to fifth segment; 12, fourth and fifth segments of female antenna, axial aspect; 13, outline of female head; 14, female trophi, ventral aspect.

Figs. 1, X 65; 13, X 105; 2-12, 14, X 210.



than wide (8 : 7), the pedicel shorter than the scape (3 : 4); the anellus very short, disk-like<sup>1</sup>); the two funicular segments approximately in ratio 2 : 3. Mandible tridentate, with one gland. Labium absent, but maxillae less reduced than in some other species: two short lobes, with one long, subapical seta.

Thorax (fig. 1) with the terga free, but the two lateral parts of the metanotum fused in the middle. Fore tibia (fig. 5) with a dorsal comb of eight teeth and with three ventrals; the two tarsal segments approximately in ratio 8 : 7. Mid leg (fig. 8) much reduced. Hind leg (fig. 2) with the tibial armature consisting of six ventral and partially antiaxial teeth, and three or four dorsals (fig. 7); the tarsal segments approximately in ratio 10 : 6 : 4 : 5 : 12.

Gaster: claspers of the genitalia with four or five claws.

Length (head and thorax) 1.1 mm. Colour yellow-brown.

Note. — In Ashmead's description the length of the single female, which may have been curved and shrunken, was given as 0.9 mm, and the ovipositor was stated to be about one-third of the length of the abdomen.

### **Kradibia sumatrana** (Grandi)

*Blastophaga sumatrana* Grandi, 1926, Treubia, 8: 352-353 (descr. ♀ ♂, Sumatra, Fort de Kock, leg. E. Jacobson, vii.1922, ex *Ficus ampelas* Bl.); Grandi, 1928c, Boll. Lab. Ent. Bologna, 1: 146-150 (redescr. type-material).

Material. — Series ♀ ♂, Indonesia, Java, Bogor, leg. J. van der Vecht & J. H. de Gunst, ex *Ficus ampelas* Burm.f.: x.1954 (RMNH 15), 9.ix (143), 27.ix (241), 6.xii (267, 270), 31.i.1955 (160), 3.ii (161), 18.iv (325, 353), 23.iv (338, 340).

### **Kradibia ghigii** (Grandi)

*Blastophaga ghigii* Grandi, 1916a, Boll. Lab. Zool. Portici, 10: 128 (key ♂); Grandi, 1916b, *ibid.*, 11: 145-149 (descr. ♂, Australia, N.S. Wales, Narara, leg. F. Silvestri, 1912, ex *Ficus stenocarpa* F. Muell.).

Host. — The name of the fig is listed by Corner (1965) as *F. fraseri* Miq.

### **Kradibia cowani** Saunders (figs. 15-26)

Material. — 2♀ 2♂, Madagascar: 4 slides from Saunders' type series in the BM (84-31).

Series ♀ ♂, Madagascar, Perinet, Analamazoatra, forêt ombrophile, leg. L. & R.

<sup>1</sup>) From Grandi's description of *K. gestroi* the anellus does not seem to exist (Grandi, 1916b: 190, fig. iv, 1). It is, however, present as a flat disk, both in the African form (Wiebes, 1969, fig. 29) and in the sample from India (Joseph, 1953: 277) that I was permitted to study.

Blommers, ex *Ficus* ? *soroceoides*<sup>1</sup>): 900 m, 6.ii.1972 (Blommers, no. 2), RMNH 2043 (slides made), 2045, 3100; 24.xii.1972 (Blommers, no. 24), RMNH 2387; 25.xii.1972 (Blommers, no. 25), RMNH 2388.

Series ♀ ♂, La Réunion, Plaine des Palmistes, route de Bébou, 1200 m, leg. J. Etienne, no. R 739, 17.iv.1975, ex *Ficus morifolia*<sup>2</sup>); RMNH 2559, ♀ and ♂ slide-mounted.

Series ♀ ♂, La Réunion, Forêt de la Mare longue, leg. J. Etienne, no. R 1075, 18.xii.1975, ex *Ficus morifolia*<sup>2</sup>); RMNH 2748.

Description. — Reference is made to the description and figures by Saunders (1883: 20-25, pl. iii), especially the male and female habitus, and the antennae.

Female. Head (fig. 25) shorter than wide across the compound eyes (12 : 13); the longitudinal diameter of the eye approximately twice as long as the cheek, and about three times as long as the temple. Three ocelli. Antenna (figs. 22-23; Saunders, figs. 39-40) with rather long segments, the apical width of which is larger than the basal width; the fifth segment bears one row of ca. twelve sensilla, the sixth to ninth two rows, viz., the subapical one incomplete, the full apical one has up to fifteen long sensilla protruding beyond the apical edge. Mandible (fig. 24) with two apical teeth, two glands, and four ventral ridges; the appendage with four distinct lamellae. Labium and maxillae (fig. 24) and also the bacilliform process, with one subapical seta each; the process is slightly longer than the distal part of the maxilla.

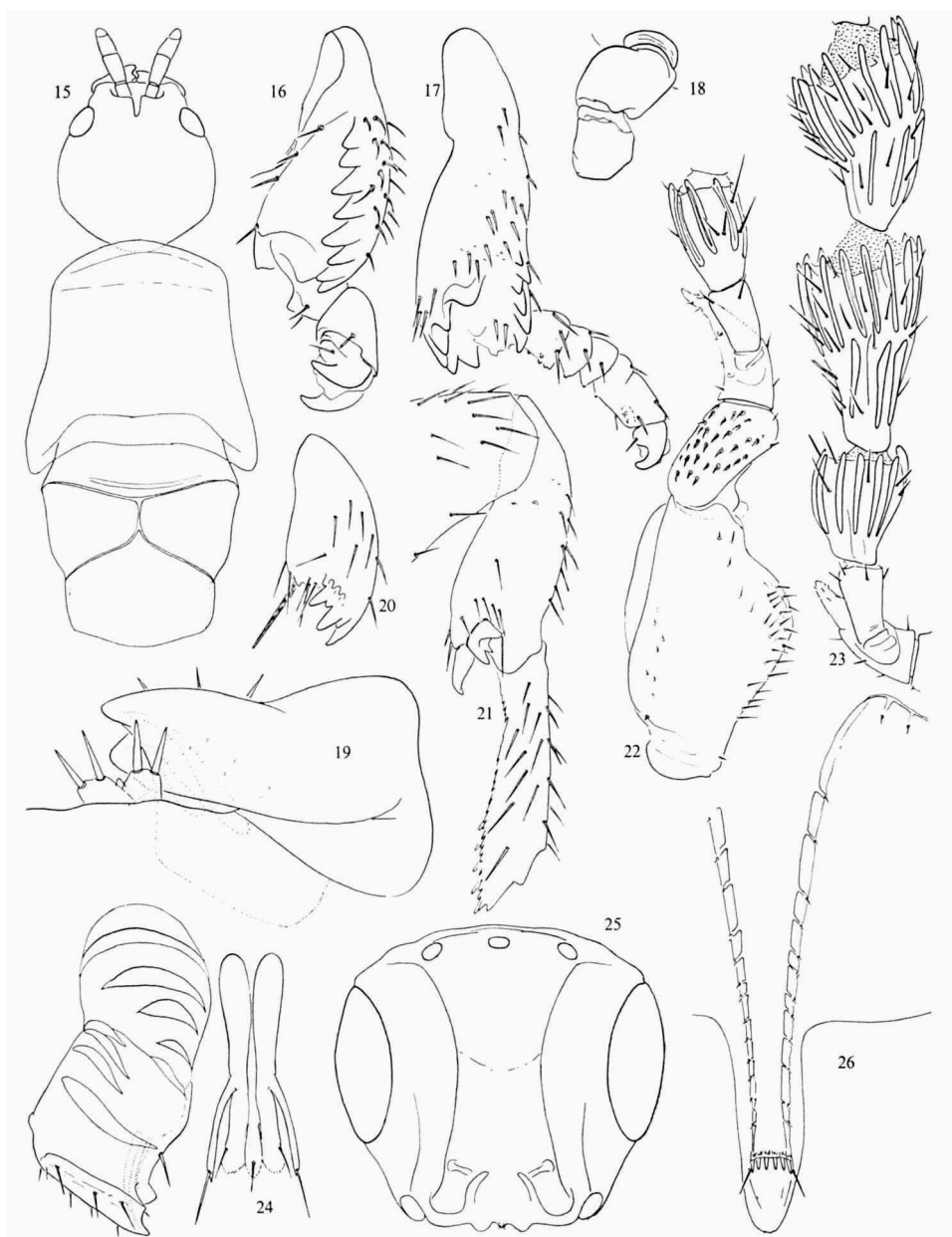
Thorax and gaster much as described for *K. gestroi* (Grandi, 1916b: 186-188, fig. i, 5); some details are added here. Submarginal, marginal, stigmal, and postmarginal veins of fore wing approximately in length ratio 7 : 5 : 3 : 5. Fore tibia (fig. 20) with six apical teeth, alternately large and small, and with a distinct ventral spur; approximate length ratio of tarsal segments 8 : 3 : 2 : 2 : 4. Mid tarsus, ratio 7 : 5 : 5 : 4 : 7. Hind leg (fig. 21); the tibia little longer than the basitarsus (11 : 10), the antiaxial tooth tricuspidate; the tarsal segments in ratio 15 : 5 : 4 : 4 : 6, with a plantar fringe. Hypopygium (fig. 26): the spine rather wide.

Length (head, thorax and gaster), 1.4 mm; the ovipositor 0.2 mm long. Colour brown.

Male. — Head (fig. 15) longer than wide (7 : 6); much as in *K. gestroi*. Compound eyes large, the longitudinal diameter one-fifth of the length of

<sup>1</sup>) The samples are either indicated as *F. ? soroceoides* or *F. soroceoides* var., and it is noted that they differ only in the shape of the leaves and the colour of the figs (yellow — nrs. 2 and 24, red — no. 25). Perrier de la Bâthie (1952: 64-68, fig. xii) described the great variation in this species; it is said to be "endémique".

<sup>2</sup>) De Cordemoy (1895: 271) listed *F. morifolia* Lam. Judging from the pollinating wasps, this is not the same as *Ficus palmata* Forsk. (*morifolia* Forsk.), which has true *Blastophaga* Gravenhorst. According to Corner (in litt.), *F. morifolia* Lam. should be named *F. laterifolia* Vahl.



Figs. 15-26. *Kradibia cowani* Saunders, male (15-19) and female (20-26). 15, male head and thorax (setae omitted); 16, male fore tibia and tarsus, antiaxial aspect; 17, male hind tibia and tarsus, antiaxial aspect; 18, vestigial male mid leg; 19, male trophi, ventral aspect; 20, female fore tibia, antiaxial aspect; 21, female hind tibia and basitarsus, antiaxial aspect; 22, antenral scape to fifth segment, axial aspect; 23, third to seventh antennal segments, axial aspect; 24, female trophi, ventral aspect; 25, outline of female head; 26, hypopygium.

Figs. 15, X 65; 25, X 105; 16-18, 20-24, 26, X 210; 19, X 420.

the head. Antenna much as described for *K. brownii* (see fig. 3), with a disk-like anellus; the funicular segments approximately in ratio 4 : 3. Trophi (fig. 19): the mandible with two glands, the maxillar vestiges with two apical setae, the labium visible as a small lobe between the maxillae.

Thorax (fig. 15) with the metanotal parts separate. Fore tibia (fig. 16) with a dorsal comb of eight teeth, and with two indistinct ventral teeth; the two tarsal segments approximately in ratio 3 : 2. Mid leg (fig. 18) reduced. Hind leg (fig. 17) with six ventral tibial teeth and with a row of six dorsals; the tarsal segments approximately in ratio 2 : 1 : 1 : 1 : 2.

Gaster: claspers of the genitalia with three claws.

Length (head and thorax) 0.9 mm. Colour yellow-brown.

Variation. — There is some variation: the specimens from Réunion tend to be slightly smaller than those from Madagascar, and the females may have a lower number of sensilla on some antennal segments (especially the fifth). The bacilliform process is not in all specimens longer than the distal part of the maxilla.

### **Kradibia gestroi** (Grandi)

*Blastophaga gestroi* Grandi, 1916a, Boll. Lab. Zool. Portici, 10: 126-128 (key ♀ ♂); Grandi, 1916b, ibid., 11: 184-193 (descr. ♀ ♂, Ceylon, Peradeniya, leg. O. Beccari, 1878, ex *Ficus* sp.); Grandi, 1928a, Bull. Soc. Zool. France, 53: 79 (♀ ♂, nr. river Mulliar, Pulneys, leg. E. Gombert, 1.v.1914, ex *Ficus asperrima* Roxb.<sup>1</sup>); Joseph, 1953, Agra Univ. J. Res., 2: 277 (♀ ♂, India, Pathanapuram Taluk, Travancore, leg. K. J. Joseph, 25.vi.1951, ex *Ficus asperrima* Roxb.<sup>1</sup>).

*Liporrhopalum gestroi afrum* Wiebes, 1969, Ann. Mus. Roy. Afr. centr. (in 8), 175: 460 (descr. ♀ ♂, Ivory Coast, Bingerville, leg. J. Decelle, vi.1961, ex *Ficus exasperata* Vahl).

Material. — Series ♀ ♂, Ceylon, Kandy, leg. E. J. H. Corner, xii.1968, ex *Ficus exasperata* Vahl; RMNH 1668.

8 ♀ 1 ♂, Ghana, Kumasi (Univ. Sci. Techn. campus), leg. L. E. Newton, 22.vi.1971, ex *Ficus exasperata* Vahl (plant no. 1404); RMNH 2003.

Series ♀ ♂, Rhodesia, Salisbury, leg. A. Watsham, vi.1977, ex *Ficus exasperata* Vahl; RMNH 3011.

33 ♀ 8 ♂, Ghana, Kumasi, Ahensai, leg. L. E. Newton, 6.vi.1971, ex *Ficus asperifolia* Miq. (plant no. 1418); RMNH 1994.

1 ♀ series ♂, Togo, leg. C. C. Berg no. 137, ex *Ficus asperifolia* Miq.; RMNH 3030.

6 ♀, Cameroons, leg. J. J. Bos no. 3603, ex *Ficus asperifolia* Miq.; RMNH 3032.

4 ♀ 14 ♂, Cameroons, leg. A. J. M. Leeuwenberg no. 9660, ex *Ficus asperifolia* Miq.; RMNH 3035.

20 ♀ 9 ♂, Gabon, near water along route Fang, 15 km from Makokou, leg. A. Hladik, 8.ii.1975, ex *Ficus asperifolia* Miq. (plant no. 2493); RMNH 2679.

? 12 ♀ (nymphs) 2 ♂, Ethiopia, leg. G. Aweke no. 696, ex *Ficus capreaefolia* Del.; RMNH 2096.

<sup>1</sup>) = *Ficus exasperata* Vahl.

? fragm. ♀, Ethiopia, leg. P. Jansen no. 5760, ex *Ficus capreaefolia* Del.; RMNH 2997.

? fragm. ♀, Ethiopia, leg. W. J. J. O. de Wilde no. 7857, ex *Ficus capreaefolia* Del.; RMNH 2995.

Hosts. — I cannot find specific differences between the material reared from the various species of fig. This is the more surprising, as *F. asperifolia*, *capreaefolia* (from which I saw insufficient material), and *F. exasperata* were classified with three different series of *Ficus* (see table 1). In my opinion, these entomological data, much as they want confirmation both by a closer inspection beyond the scope of the present paper and by biological observations, should lead to a revaluation of the botanical classification.

**Kradibia hilli** spec. nov. (figs. 27-44)

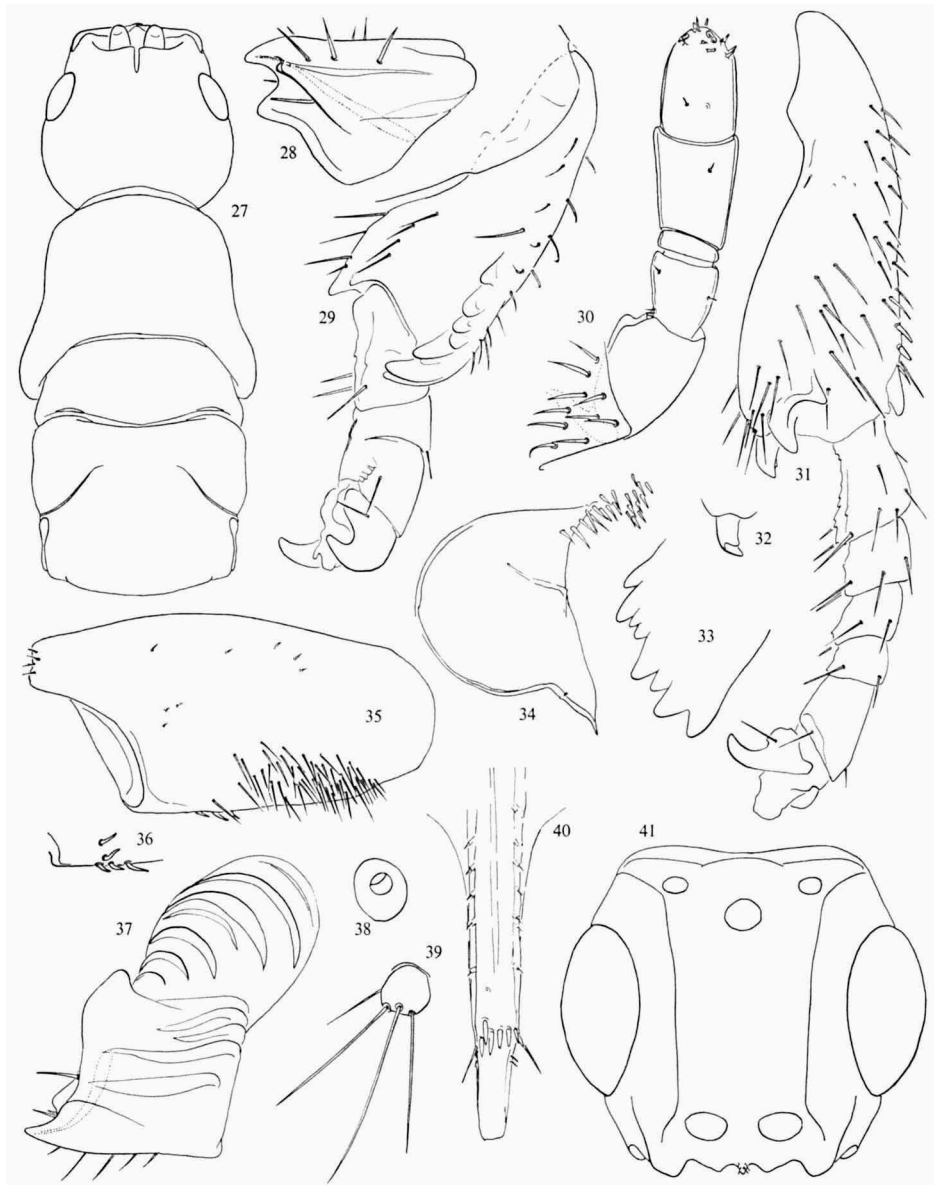
Material. — 17 ♀ 11 ♂, Uganda, Katalamwa, leg. D. S. Hill, 29.x.1968, no. 19, ex *Ficus urceolaris*<sup>1</sup>); RMNH 1306, ♀ holotype and ♀ ♂ paratypes slide-mounted.

ca. 20 ♀ 15 ♂ (fragmented), Tanganyika, Mpanda, Ntakatta forest, leg. J. Kielland, i.1970, ex *Ficus* sp.; RMNH 2214.

Description. — Female. Head (fig. 40) shorter than wide across the compound eyes (6 : 7); the longitudinal diameter of the eye over twice as long as the cheek (7 : 3), and twice as long as the temple. Three ocelli. Epistomal margin deeply and rather angularly lobed. Antenna (fig. 42) ten-segmented, from the fifth segment onwards with oblong sensilla in two (on segment five) or three rows (the other segments); the fifth is not quite twice as long as wide (5 : 3), the sixth to ninth are almost three times as long as wide, the tenth slightly longer. Mandible (fig. 37) with two apical teeth, but one gland, its ventral surface with four ventral ridges; the appendage rather weak, with five large and two smaller transverse lamellae. Labium and maxillae much as in *K. cowani* (see fig. 24), but the labium without seta, the maxillar bacilliform process approximately half as long as the distal part of the maxilla.

Thorax. Fore wing (2 : 1) 2.2 mm long; the submarginal, marginal, stigmal, and postmarginal veins approximately in ratio 13 : 4 : 4 : 8, the membrane with dense microtrichia and faint venae spuriae; the hind wing (4 : 1) 1.2 mm long. Fore leg (fig. 43): the coxa (fig. 35) with a patch of fine setae; moreover, some spines occur antiaxially, as indicated in fig. 36; the tibia has rather long setae and an apical comb of four sharp dorsal teeth and one blunt tooth (with an auxiliary, smaller next to it) and one ventral, while axially there are a number of hyaline spines as also on the tarsus, and

<sup>1</sup>) According to DeWolf (1964: 16) the plant common around Lake Victoria, usually called *F. urceolaris*, probably is *F. stortophylla* Warb.



Figs. 27-41. *Kradibia hilli* spec. nov., male (27-33) and female (34-41). 27, male head and thorax (setae omitted); 28, male mandible, ventral aspect; 29, male fore tibia and tarsus, antiaxial aspect; 30, male antenna, dorsal aspect; 31, male hind tibia and tarsus, antiaxial aspect; 32, do., detail in axial aspect; 33, comb of male fore tibia, dorsal aspect; 34, female pollen pocket, ventral aspect; 35, female fore coxa, axial aspect; 36, do., detail in antiaxial aspect; 37, female mandible, ventral aspect; 38, outline of stigma of eighth urotergite; 39, pygostyle; 40, hypopygium; 41, outline of female head.

Figs. 27, X 65; 41, X 105; 28-40, X 210.

a spur; the tarsal segments approximately in ratio 10 : 4 : 3 : 4 : 10. Length-ratio of mid tarsi 6 : 3 : 3 : 3 : 4. Hind tibia (fig. 44)  $1\frac{1}{2}$  times as long as the basitarsus, the setae are rather long, and the armature consists of an axial hook and an indistinctly tricuspidate, antiaxial tooth; the tarsal segments approximately in ratio 9 : 4 : 4 : 3 : 5, expanded ventrally in a ventral fringe.

Gaster: the hypopygium (fig. 40) much as in *K. cowani* (see fig. 25), but the spine more elongate; the spiracular peritremata of the eighth urotergite very small; the pygostyle subglobose, with four long setae.

Length (head, thorax and gaster) 1.7 mm; the ovipositor 0.5 mm long. Colour light brown.

Male. — Head (fig. 27) slightly longer than its maximum width (16 : 15), much as in *K. gestroi*. Compound eyes very large, the longitudinal diameter one quarter of the length of the head. The antennae are situated in a common shallow groove, which dorsally narrows in a median slit. Antenna (fig. 30) consisting of five free segments: the scape distinctly longer than wide (9 : 7), the pedicel much shorter than the scape (2 : 3); the anellus rather long compared to that of *K. gestroi*, one-fifth of the length of the first funicular segment, which is about as long as the second. Mandible (fig. 28) tridentate, with one gland. Labium and maxillae reduced to a bilobed structure, with two apical setae (cf. Grandi, 1916b, fig. iv, 3).

Thorax (fig. 27) with most terga free, much like in *K. gestroi*, but the pronotum rather short, and the propodeum not fully separated from the metanotum. Fore tibia (fig. 29) with a comb of eight inequal dorso-apical teeth (fig. 33) and two ventrals; the three tarsal segments approximately in ratio 9 : 3 : 5, the basitarsus without the ventral prominence peculiar to the other species of *Kradibia*; the second and third segments incompletely separate, or even the third again divided into two parts. Mid leg small, with only three tarsi (1 : 1 : 2). Hind tibia (fig. 31) with a robust, bicuspidate antiaxial crest, and a bidentate ventral tooth (fig. 32), the tarsal segments approximately in ratio 8 : 5 : 4 : 3 : 6.

Gaster: claspers of the genitalia with two claws.

Length (head and thorax) 0.7 mm. Colour yellow-brown.

***Kradibia setigera* spec. nov. (figs. 45-50)**

Material. — 4 ♀, North Borneo, Sungei Liwagu, 4000' alt., leg. E. J. H. Corner, no. RSNB 2534, 29.viii.1961, ex *Ficus leptogramma* Corner; RMNH 645, 2 ♀ slide-mounted.

Description. — Female. Head (fig. 49) slightly shorter than wide across the compound eyes (9 : 10); the longitudinal diameter of the compound eye  $2\frac{1}{2}$  times as long as the cheek, three times as long as the temple. Three ocelli.

Epistomal margin rather straight, the median prominence sharp. The face has many long setae, as partly indicated in the figure. Antennae broken off beyond the fifth segment: here again e.g. on the pedicel, the setae are rather long (fig. 50); the fifth segment bears some twenty oblong sensilla. Mandible (fig. 45) with two apical teeth, two glands, and three large (but weak and hyaline) lamellae; the weak appendage bears eight transverse lamellae, some of which are rather indistinct. Labium and maxillae without long setae.

Thorax and legs with long setae. Fore wing (2 : 1) 2.3 mm long; the submarginal, marginal, stigmal, and postmarginal veins approximately in ratio 65 : 8 : 9 : 15; the membrane with dense microtrichia and venae spuriae; the hind wing (4 : 1) 1.4 mm long. Fore leg: the tibia (fig. 46) with an apical comb of four dorsal teeth, and one ventral; one axial spur; the tarsus with many spines, the segments approximately in ratio 15 : 5 : 4 : 5 : 7. Mid leg, tarsal ratio 12 : 4 : 4 : 3 : 4. Hind leg: the tibia with two apical teeth (fig. 47), the antiaxial one bicuspidate, the axial simple; the tarsus with many spines, the segments approximately in ratio 15 : 6 : 6 : 4 : 5, the claws slender.

Gaster: the spine of the hypopygium (fig. 48) rather long; the spiracular peritremata small, subcircular; the pygostyle short, quadrate in lateral aspect, the four setae not very long.

Length (head, thorax and gaster) 2.4 mm; the ovipositor 0.5 mm long i.e., ca. half as long as the gaster. Colour brown.

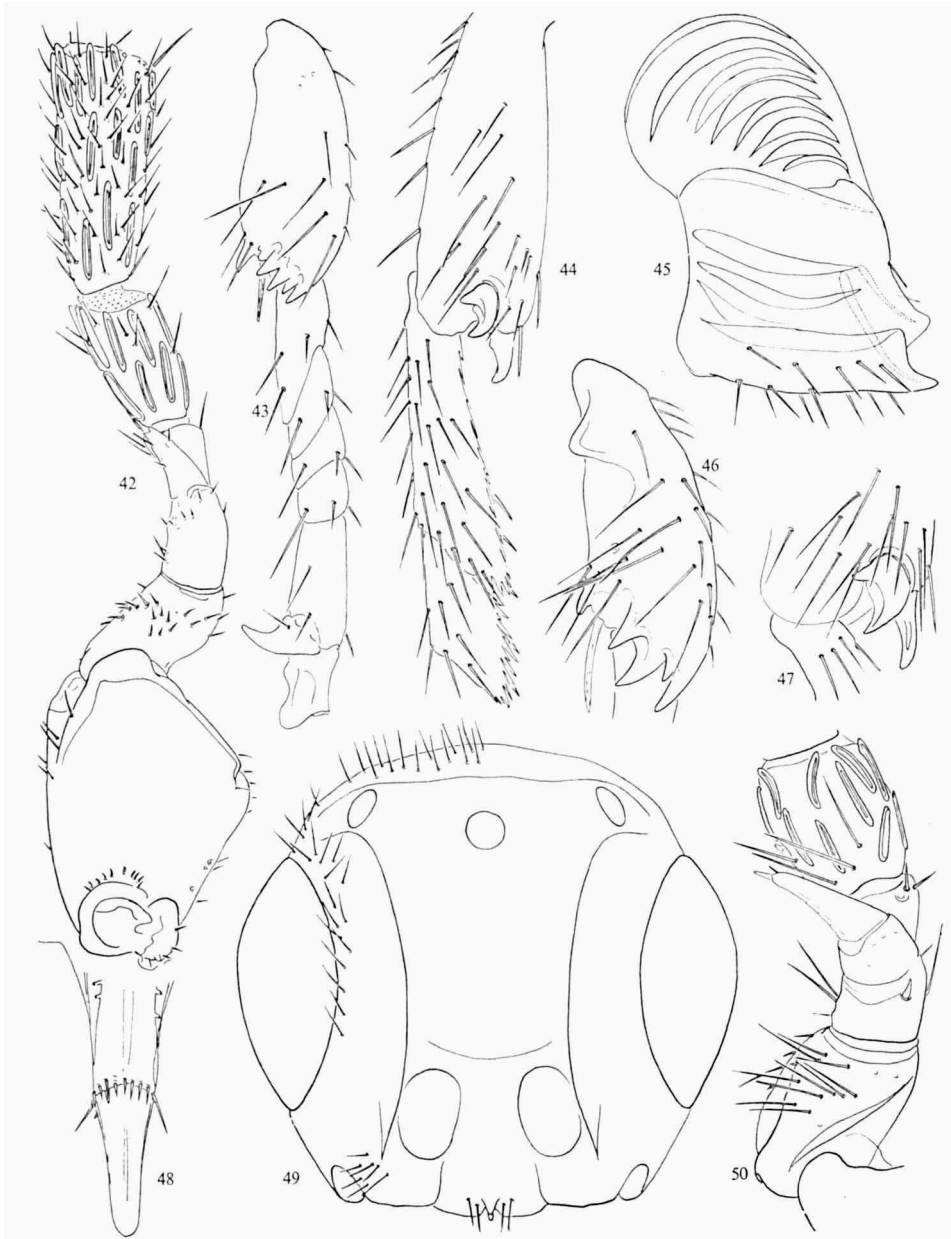
### ***Ceratosolen internatus* spec. nov. (figs. 51-60)**

Material. — Series ♀ ♂, Java, leg. J. van der Vecht, ex *Ficus asperiuscula* K. & B.: 28.x.1954 (Bogor, RMNH 56), 20.xi.1954 (Telaga Warna, RMNH 102; type-lot: ♀ holotype and ♀ ♂ paratypes slide-mounted), 13.xii.1954 (Bogor, Tjilendek, RMNH 206), 20.xii.1954 (Tjibodas, RMNH 213).

20 ♀ 25 ♂, Sumatra, Pajakumbuh, leg. W. Meijer, 5.vii.1956, ex *Ficus asperiuscula* K. & B.; RMNH 460.

Description. — Female. Head (fig. 59) shorter than wide across the compound eyes (7 : 8); the longitudinal diameter of the eye more than half as long as the head (8 : 14), and not quite twice as long as the cheek (8 : 5). Ocelli atrophied. Epistomal margin distinctly lobed. Antenna (fig. 56) ten-segmented; the scape robust, over twice as long as the pedicel (7 : 3), the third segment and its appendage rather strong, the fourth small, the fifth almost twice as long as the fourth, with one row of oblong sensilla; the sixth to tenth very long, three times as long as the fifth, with about four irregular rows of oblong sensilla and many setae. Mandible (fig. 60) with six ventral lamellae, the appendage with ten; the labium without setae, the maxilla with one subapical seta and a short bacilliform process.





Figs. 42-44. *Kradibia hilli* spec. nov., female. 42, antenna, antiaxial aspect; 43, fore tibia and tarsus, antiaxial aspect; 44, hind tibia and two tarsal segments, antiaxial aspect. Figs. 45-50. *Kradibia setigera* spec. nov., female. 45, mandible, ventral aspect; 46, fore tibia, antiaxial aspect; 47, apex of hind tibia, antiaxial aspect; 48, spine of hypopygium; 49, outline of head (setae indicated in one half); 50, antennal pedicel and third to fifth segments, antiaxial aspect.

Figs. 49, X 105; 42-48, 50, X 210.

Thorax. Fore wing (11 : 5) 2.2 mm long; the submarginal, marginal, stigmal, and postmarginal veins approximately in ratio 14 : 4 : 4 : 7, the membrane with many microtrichia; the hind wing (5 : 1) 1.3 mm long. Fore leg: the tibial comb (fig. 57) consisting of four sharp teeth; a distinct spur; the tarsal segments approximately in ratio 8 : 4 : 4 : 5 : 7, with a plantar fringe. Mid leg slender, the tarsal ratio 3 : 2 : 2 : 2 : 3. Hind leg with rather heavy axial spines and with long setae, especially on tibia and tarsus; the tibial armature (fig. 58) consisting of a tricuspidate antiaxial tooth and a bidentate axial; the tarsal segments approximately in ratio 12 : 5 : 3 : 3 : 5, with a plantar fringe.

Gaster: the hypopygium much as described and figured for *Kradibia hilli* (see fig. 40); the spiracular peritremata large, ovoid in outline; the pygostyle twice as long as wide, with four long setae.

Length (head, thorax and gaster) 1.8 mm; the ovipositor 0.3 mm long i.e., half as long as the gaster. Colour dark brown, legs and antennae lighter.

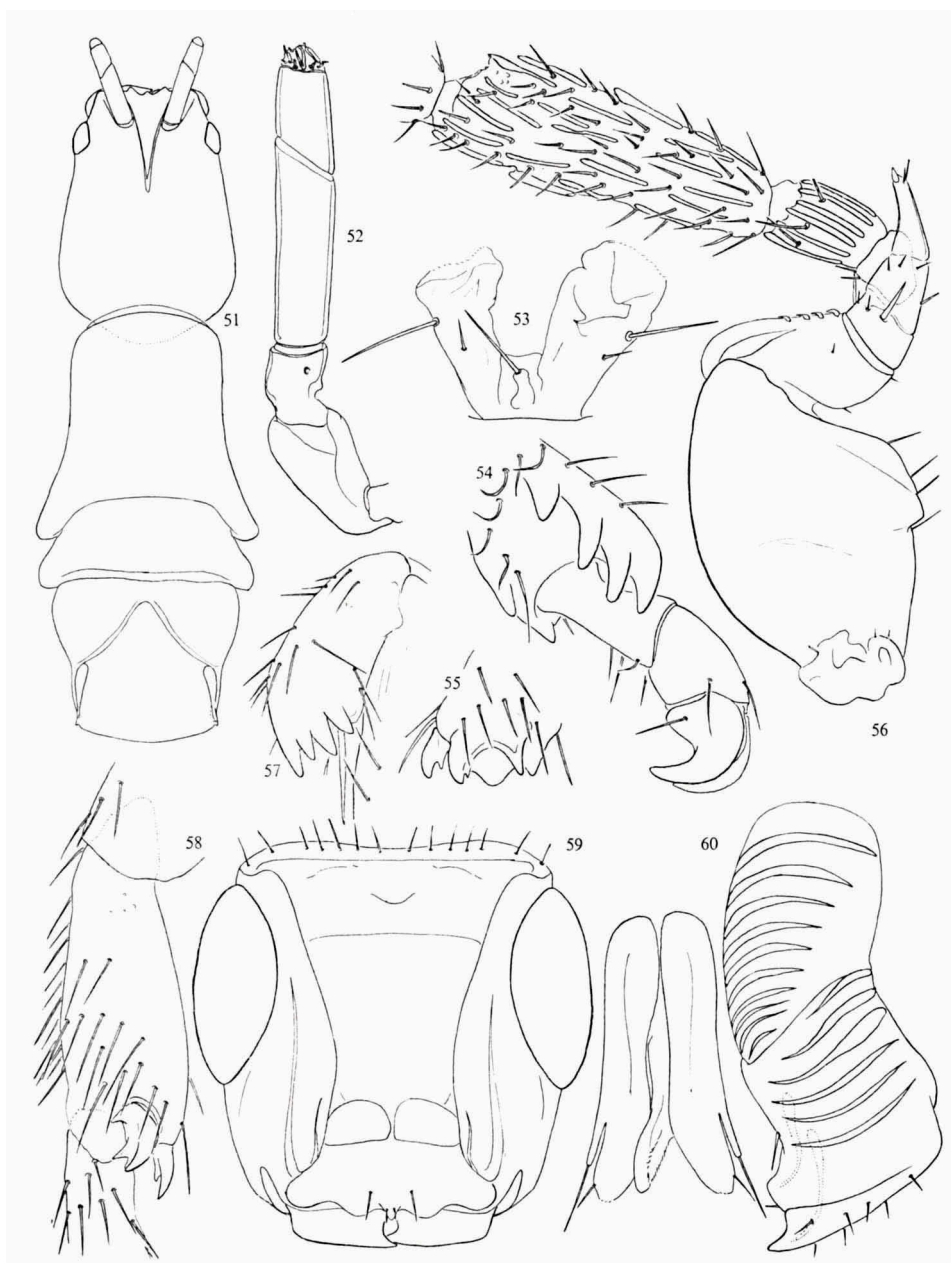
Male. — Head (fig. 51)  $1\frac{1}{2}$  times as long as wide; the compound eyes large, as long as the cheek; the clypeus with three lobes; the antennae inserted in separate pockets. Antenna (fig. 52): the scape twice as long as the pedicel; one short disk-like anellus; two funicular segments (ratio 15 : 8). Mandible much as in some species of *Kradibia*, but the labium and maxillae (fig. 53) less reduced: each with one long seta, the maxilla with a second seta.

Thorax (fig. 51) with the same structure as in *Kradibia*; in the sample from Sumatra, the metanotal plates are fully separate, the sutures reaching to the border of the meso- and the metanotum (in the middle: propodeum). Fore leg: tibia (fig. 54) with a comb of four dorsal teeth, the ventral apex with two teeth; the tarsal segments approximately in ratio 10 : 7. Mid leg slender, but complete; the four tarsal segments approximately in ratio 5 : 3 : 3 : 4. Hind leg: the tibial armature (fig. 55) consisting of a large antiaxial bicuspidate crest, one tooth of which bears an auxiliary one, and one bidentate axial; the four tarsal segments approximately in ratio 5 : 3 : 3 : 7.

Gaster: the claspers of the genitalia with four claws.

Length (head and thorax) 1.5 mm. Colour yellow-brown.

Note. — *Ceratosolen internatus* runs to couplet 7 in my key to the species of *Ceratosolen* (Wiebes, 1963: 88-89). The female can quite easily be distinguished from *C. gravelyi* Grandi by the long antennal segments. The male is more similar, but for the four-segmented mid and hind tarsi; moreover, the male of *C. gravelyi* is blind, and that of *C. internatus* is not.



Figs. 51-60. *Ceratosolen internatus* spec. nov., male (51-55) and female (56-60). 51, male head and thorax (setae omitted); 52, male antenna, ventral aspect; 53, male maxillae and labium, ventral aspect; 54, male fore tibia and part of tarsus, antiaxial aspect; 55, apex of male hind tibia, antiaxial aspect; 56, scape of female antenna, to sixth segment, antiaxial aspect; 57, female fore tibia, antiaxial aspect; 58, female hind tibia and part of tarsus, antiaxial aspect; 59, outline of female head; 60, female trophi, ventral aspect.

Figs. 51, X 65; 59, X 105; 52, 54-58, 60, X 210; 53, X 420.

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